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Environmental Implementation Guide for Radiological Survey Procedures

Office of Environmental Policy and Assistance
Assistant Secretary for Environment, Safety, and Health
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1. INTRODUCTION

1.1 PURPOSE AND SCOPE

This manual contains a set of guidelines and recommendations for the Department of Energy (DOE) and DOE contractors to use in planning, conducting, and/or evaluating a radiological survey. The scope of surveys to characterize property should be commensurate with the potential for contamination of the property. The procedures described in this manual entail a multi-step process that was developed to ensure the conduct of adequate radiological surveys and the effective use of resources for radiological characterization. The manual is written for a technical audience familiar with the principles of basic applied health physics though not necessarily having survey expertise. The inexperienced user or evaluator should be able to understand and follow the guidance provided by the manual and implement it directly in simple situations. But when the survey is large and the conditions complex, experienced radiological professionals should be consulted.

This manual will help the user define necessary measurements required for a specific survey, and lead the user to the sections of the manual where the procedures for those measurements are described. The user may then incorporate the appropriate sections into the survey plan and conduct the survey accordingly, or select useful sections and describe alternative procedures (and justifying rationale) for other recommended procedures.

DOE personnel (or, where appropriate, other Federal, State or local organizations) responsible for approving survey plans or evaluating the results of the survey may use the manual to determine if a survey was adequate without reading the entire manual. Based on a reasonable amount of knowledge of the site, the evaluator should be able to identify the type of survey, the level of detail, and acceptable procedures with relative ease. It should be recognized that the details and complexity of an acceptable survey are dependent on the desired data and program needs. Therefore, survey designs for similar properties may differ based on data needs and objectives. A data quality objective program will be useful in scoping survey needs.

1.2 INSTRUCTIONS FOR USE OF MANUAL

The user of this manual should first consult the Site Assessment Process Flowchart (Fig. 1.1) and the description of the process as given in Sect. 2. This chart shows the steps and decisions required in the radiological assessment and remediation process and refers to sections of the manual that give guidance on collecting information required for decision making.

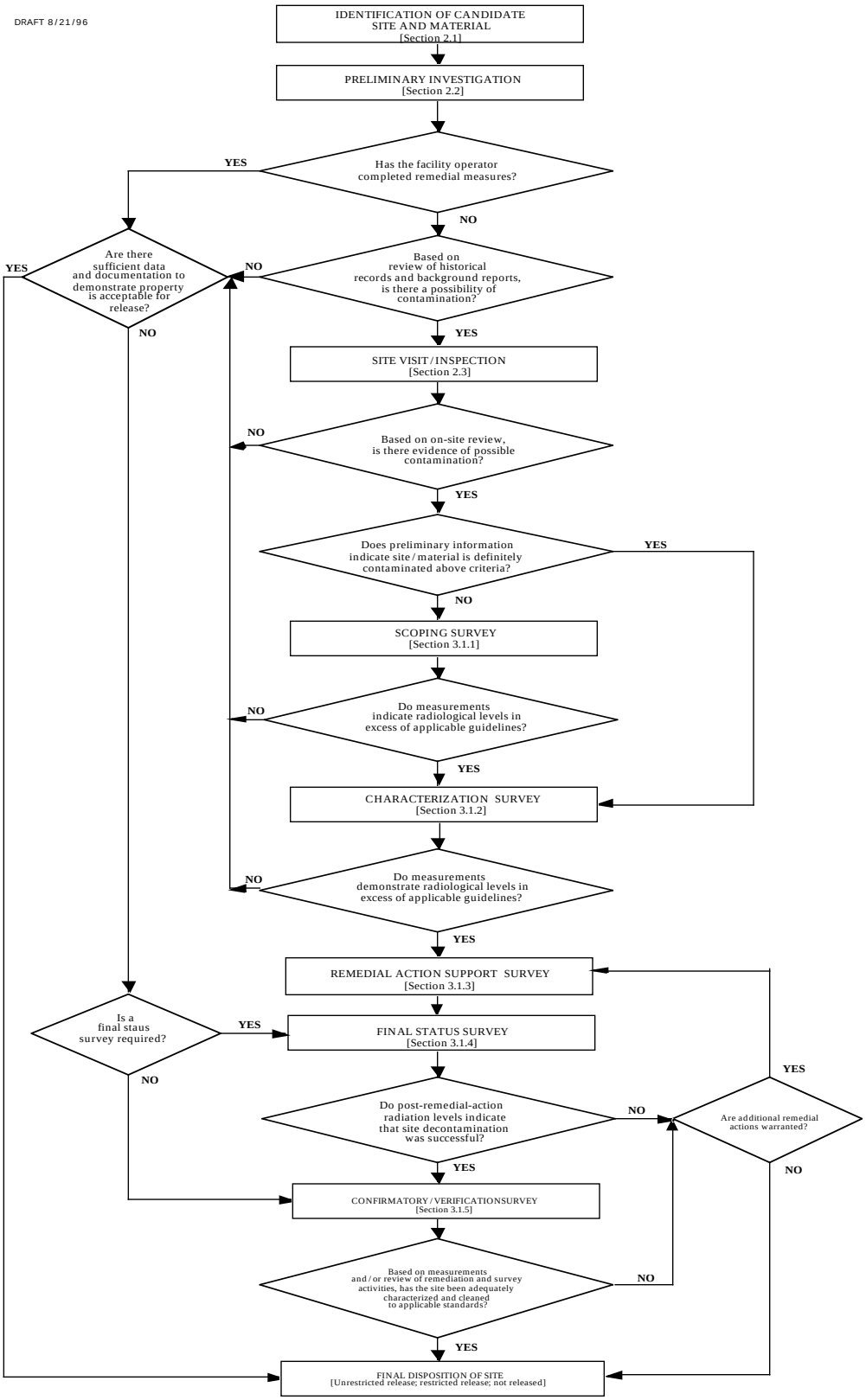

Fig. 1.1. Site Assessment Process Flowchart

		SITE PREPARATION (Section 4.1)			RADIATION MEASUREMENTS (Section 4.3)						
		Property Boundaries/ Civil Survey (4.1.1)	Clearing To Provide Access (4.1.2)	Reference Grid System (4.1.3)	Alpha (4.3.1) Direct		Beta (4.3.2) Direct		Gamma (4.3.3) Direct		Subsurface Hole Logging (4.3.4)
					Scan	Static	Scan	Static	Scan	Static	
SCOPING SURVEY (Section 3.1.1)	INDOOR	N	WA	N	Y	Y	Y	Y	Y	Y	WA
	OUTDOOR	N	WA	N	WA	WA	WA	Y	Y	Y	WA
CHARACTERIZATION SURVEY (Section 3.1.2)	INDOOR	Y	WA	Y	Y	Y	Y	Y	Y	Y	WA
	OUTDOOR	Y	WA	Y	WA	WA	WA	Y	Y	Y	WA
REMEDIAL ACTION SUPPORT SURVEY (Section 3.1.3)	INDOOR	N	WA	Y/WA	Y	Y	Y	Y	Y	Y	N
	OUTDOOR	N	WA	Y/WA	WA	WA	WA	Y	Y	Y	N
FINAL STATUS SURVEY (Section 3.1.4)	INDOOR	N	N	Y/WA	Y	Y	Y	Y	Y	Y	N
	OUTDOOR	N	N	Y/WA	WA	WA	WA	Y	Y	Y	N
CONFIRMATORY/ VERIFICATION SURVEY (Section 3.1.5)	INDOOR	N	N	Y/WA	Y	Y	Y	Y	Y	Y	WA
	OUTDOOR	N	N	Y/WA	WA	WA	WA	Y	Y	Y	WA

Y = YES N = NO WA = WHERE APPLICABLE: SITE-SPECIFIC.

Fig. 1.2. Matrix for Radiological Surveys. [Copy or remove and lay end-to-end with the following page.]

SAMPLING (Section 4.4)							BACKGROUND MEASUREMENTS (Section 4.5)	
Removable Activity (Smears) (4.4.1)	Soil (4.4.2)		Water (4.4.3)	Air (4.4.4)	Radon (4.4.5)	Miscellaneous (4.4.6)	Gamma Exposure Rates	Soil Radionuclide Concentrations
	Surface	Subsurface						
Y	Y/WA	WA	WA	WA	WA	WA	Y	WA
WA	Y/WA	Y	WA	WA	WA	WA	Y	Y
Y	Y/WA	WA	WA	WA	WA	WA	Y	WA
WA	Y/WA	Y	WA	WA	WA	WA	Y	Y
Y	Y/WA	WA	WA	WA	WA	WA	WA	WA
WA	Y/WA	Y	WA	WA	WA	WA	WA	WA
Y	WA	WA	WA	WA	WA	WA	WA	WA
WA	WA	WA	WA	WA	WA	WA	WA	WA
Y	WA	WA	WA	WA	WA	WA	WA	WA
WA	Y/WA	WA	WA	WA	WA	WA	WA	WA

Fig. 1.2. (continued)

When a decision has been made to conduct a survey and the type of survey (Sect. 3) has been identified, the user should consult the matrix (Fig. 1.2) to determine what measurements/samples are required for that particular type of survey. References given in this matrix will lead the user to the appropriate section of the manual (Sect. 4) where the procedures for those measurements/samples are described. Applicable requirements and procedures may then be incorporated into the survey plan.

Section 5 describes the appropriate instruments to be used for each type of measurement and includes both field and laboratory instrumentation. Section 6 deals with sample preparation and laboratory analysis methods. Section 7 describes the interpretation of survey results. Sections 8 and 9 give guidance on data reporting and management, and quality control/assurance. Sect. 10 provides definitions and terminology. The reference section includes a number of documents that are not directly cited in the text but that may aid in expanding the user's base of knowledge regarding specific survey-related topics. Specialized terminology and concepts of particular importance to the survey process are bolded for emphasis.

1.3 CRITERIA, GUIDELINES, AND UNITS OF MEASURE

DOE requires that property that has been or is suspected of being contaminated with radioactive material be adequately surveyed (radiologically characterized) to ensure that the property meets approved authorized limits or release guidelines and that the results be adequately documented. Radiological surveys are performed to ensure or verify that a site or piece of property (real estate,* equipment, personal property) will not expose individuals to unacceptable levels of radiation and radioactive materials, and when materials are being released from DOE control, to demonstrate that allowable limits for residual radioactive material have not been exceeded.

1.3.1 Generic Guidelines

In general, DOE requires that authorized limits for release of property containing residual radioactive material be developed and approved prior to the release of such property. However, the DOE-approved guidelines shown in Appendix A for indoor radiation and for radionuclide concentrations in soil (generic and "hot spot") are those currently used under ordinary circumstances for establishing release criteria for activities subject to DOE regulatory requirements. These guidelines ensure that the primary dose limit contained in Chaps. II and IV of Order DOE 5400.5, and in Subpart G of proposed 10 CFR Part 834 (Radiation Protection of the Public and Environment),** will

*Real property (real estate) is characterized by its immobility and tangibility. It comprises land and all things of a permanent and substantial nature affixed thereto by any means. *Sources*: Order DOE 4330.4A; C. K. Smoley, *Dictionary & Thesaurus of Environment, Health, and Safety*, U.S. Department of Energy, Safety, and Health, CRC Press, Inc., Boca Raton, FL, 1992.

**Until final promulgation of 20 CFR Part 834, clarification on several issues relating to Order 5400.5 may be found in R. F. Pelletier, Director, Office of Environmental Policy and Assistance, "Application of DOE 5400.5 requirements for release and control of property containing residual radioactive material,"DOE guidance memorandum to Distribution, November 17, 1995 and R. F. Pelletier, Director, Office of Environmental Policy and Assistance, "Order DOE 5400.5 requirements for control of settleable solids," Guidance memorandum to Distribution, December 6, 1995.

not be exceeded and that the doses will be as far below that limit as practicable as determined using the "as low as reasonably achievable" (ALARA) process.* The guidelines typically refer to radiation and concentrations of radionuclides above normal background levels and are nuclide specific. Appendix A lists default limits for surface contamination for all isotopes and soil limits for a few isotopes. These guidelines are subject to change and may be replaced in the future with alternate dose-based site-specific guidelines. For practical application, limits are typically expressed in terms of direct radiation levels, surface activity levels, and/or concentrations of radioactive material in soil and building materials which correlate to the basic dose limit.

- Limits for direct radiation levels, when applicable, are expressed in units of dose or exposure rate. 1) microroentgens per hour (μR/h) for direct air gamma exposure rates, 2) millirem per hour (mrem/h) or millisievert per hour (mSv) direct body dose equivalent rate, and 3) millirad per hour (mrad/h) or microGray per hour (μGy/h) for localized dose rates such as shallow skin dose from beta radiations.

- Surface activity guidelines, applicable to building or equipment surfaces, are expressed in units of activity per surface area, typically disintegrations per minute per 100 cm^2 (dpm/100 cm^2), or picocurie (pCi) [becquerel (Bq)] per unit surface area.

- Concentration guidelines, which apply to soil, induced activity, and debris, have guidelines that are expressed in terms of activity per unit mass [typically, picocuries per gram (pCi/g) or becquerels per gram (Bq/g)].

- In liquids, gases, and air, concentrations are expressed in terms of activity per unit volume (μCi/mL or Bq/cm^3).

1.3.2 Derived (Site-specific) Limits

Survey procedures and requirements are very dependent on the intended use of the results (see Sect. 1.4, Data Quality Objectives). For instance, if data are being collected for the purpose of assessing potential or past doses or risks from use of the site or to demonstrate compliance with dose or risk criteria, the data should be sufficient to provide an estimate of central tendency and uncertainty (e.g., 95% confidence intervals). These data can be used as input to models and pathway analyses. If the data are being collected to demonstrate compliance with release criteria, the details needed may be different and will depend on the form of the release criteria. The type and amount of data to be collected will be defined to satisfy all parameters necessary to perform the assessment. The data required for statistical comparison to the various types of limits and the form in which the data will be applicable for these comparisons are discussed in more detail in Sect 7.

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*See *DOE Guidance on the Procedures in Applying the ALARA Process for Compliance with DOE 5400.5*, Department of Energy, Office of Environmental Guidance, March 8, 1991 and *Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0*, ANL/EAD/LD-2, Chapters 1 and 5, and Appendix M, September 1993.

Calculated levels and limits that are required on a case-by-case, or site-by-site basis are known as derived limits or derived concentration guidelines (DCG) and are defined by the responsible Federal agency [DOE, U.S. Environmental Protection Agency (EPA), or the Nuclear Regulatory Commission (NRC)]. They are calculated by using analyses of various pathways (e.g., direct radiation, inhalation, ingestion) and scenarios through which the exposures occur. The calculations are performed to identify levels of radioactive material that could be present and still ensure that acceptable doses and/or risks are not exceeded.

For real property, the limits and survey protocol should be developed for specific release actions. These may include one building, several buildings and lands, or portions of a structure. Authorized limits may be approved for either unrestricted or restricted release. Authorized limits may also be developed for operational release of non-real property; e.g., equipment, small items and waste (see Sect. 4.6). When authorized limits are derived and approved for a specific application (e.g., a remedial action that addresses a large area of land and several structures), situations can occur where the authorized limit is not applicable for selected portions of the site (e.g., pipes embedded in a concrete floor, a cliff-like area, or a graveyard). For such situations, DOE may approve limits that supplement the authorized limits ("supplemental limits") if these supplemental limits provide adequate protection of the public and have been determined consistent with the ALARA process.

Derived concentration guideline values will be isotope-specific. If more than one radionuclide is present, release limits for each radionuclide must be applied individually so that the sum of the fractional contributions from individual radionuclides will not be more than one (1) i. e., the unity rule is applied.

Additional guidance to that provided in DOE 5400.5 and in 10 CFR Part 834, particularly for derived limits, is contained in the *Implementation Guide for Decommissioning, Deactivation, Decontamination, and Remedial Action of Property with Residual Contamination; Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD,* ANL/EAD/LD-2, Argonne Natl. Lab.; *RESRAD-Build: A Computer Model for Analyzing the Radiological Doses Resulting from the Remediation and Occupancy of Buildings Contaminated with Radioactive Material,* ANL/EAD/LD-3, Argonne Natl. Lab.; and DOE/CH-8901, June 1989.

1.4 DATA QUALITY OBJECTIVES

This report provides guidelines for determining the type, quality, and quantity of samples or measurements needed for radiological surveys. However, the optimal number of samples, grid spacings, and other details of the sampling plan needed to achieve site-specific decision-making goals must still be determined by the survey planning team. Two closely related planning processes can aid significantly in developing the site-specific plan: the Data Quality Objectives (DQO) process developed by the U.S. Environmental Protection Agency and the Streamlined Approach for Environmen-

tal Restoration (SAFER) developed by DOE. Both approaches are consistent with the procedures described in this manual, and it is anticipated that they will be implemented according to the professional judgment of the responsible individuals.

The DQO process was developed to avoid collecting irrelevant or unnecessary data so that only the required type, quantity, and quality of data are obtained and used for decision making. The process specifies that stakeholders (e.g., DOE, State and local regulatory groups, and public-interest groups) work together to develop mutually acceptable site-specific and decision-specific plans. The DQO process has seven steps.

1. State the problem.
2. Identify the decision.
3. Identify inputs to the decision.
4. Define the study boundaries.
5. Develop a decision rule.
6. Specify limits on decision errors.
7. Optimize the design for obtaining data.

Guidance and example applications of the DQO process are provided by EPA (1992, 1993b, 1993c; 1994a and 1994b) and Neptune et al., 1990.

The SAFER process integrates aspects of the DQO process and the Observational Approach. Guidance on applying SAFER to the Remedial Investigation/Feasibility Study process is provided in DOE 1993a. The Observational Approach is discussed by Peck (1969). SAFER was developed to streamline environmental restoration efforts while taking into account uncertainties and the need to link data collection and decision-making needs, to converge early on a remedy, and to obtain participation and consensus from key stakeholders. As radiological surveys are an important part of environmental restoration efforts at many sites, the readers of this guidance should be familiar with both the SAFER and DQO approaches.

2. SITE ASSESSMENT PROCESS

The Site Assessment Process Flowchart (Fig. 1.1) illustrates the steps and decisions required in a radiological assessment and remediation of a potentially contaminated site or material* and indicates the relationships of the five survey types in the overall assessment process. Some of the descriptions and requirements in this section assume that some time may have passed between the time the survey was conducted or radiological information was collected, and the time when the radiological information is used. In those instances where operating facilities are to be decontaminated, a great deal of site information may be readily available and specific site investigations need not be as detailed as outlined here. The specific details and the level of the investigation are a function of the radiological activities and should reflect the amount and quality of information available.

2.1 IDENTIFICATION OF CANDIDATE SITE AND MATERIAL

The first step of the Site Assessment Process is to identify a candidate site. Candidate sites may be identified through the following:

- Records review (e.g., facility or corporate records, Manhattan Engineer District (MED)/Atomic Energy Commission (AEC)/DOE contract and general correspondence files).

- Conduct of ground and/or aerial radiological surveys of general areas known to have processed/handled radioactive materials.

- Interviews with contacts who have knowledge of the facility, site, or radioactive materials.

The candidate site should be identified by name, location, and current legal owner (where possible). Supporting information may include legal transactions (e.g., property ownership), past procurement activities, changes in site names, and land usage modifications.

2.2 PRELIMINARY INVESTIGATION

2.2.1 Purpose

The purpose of this investigation is to review information for the organized planning of the initial visit or inspection of the site.

*Material is intended to include non-real property such as large and small equipment, personal property, or recyclable material.

2.2.2 History of Facility/Documentation

Review records and any other information relevant to the property of concern, the types of materials that might be involved, and the type and levels of radioactive contamination that might be anticipated. Identification of the starting materials, intermediates, and end products is of particular interest. It is also important to identify activities conducted in various parts of facilities and, when equipment or other material is of concern, where and how they were used. All sources should be assessed and the information thoroughly researched, particularly in the case of older sites where corporate memory has been lost or site functions have changed. Some or all of the following sources may be useful and necessary if available; others may be unnecessary in the event that sufficient information is otherwise accessible.

Examples of pertinent information sources for documentation of site history include but are not limited to the following:

1. relevant historical documents of radiological activities at a site including past and current site usage data;
2. previous radiological surveys and resulting data;
3. documents of ownership;
4. site plats, blueprints and drawings, maps, diagrams, and photographs;
5. geological, hydrogeological, topographical, or meteorological data; and
6. all available drawings and sketches concerning structures located on-site.

This information can usually be obtained from previous or current site owners, local municipal agencies and libraries, and/or other sources. Often much of this information is provided directly by the DOE or DOE contractors. All available documents pertinent to an assigned candidate site should be reviewed.

• Site usage history

Review the site usage history, paying special attention to the parameters that may indicate potential areas of contamination or that may affect radiation exposures to the public and workers. Examples of particularly relevant information are

1. length and scope of operations related to use or handling of radioactive material;
2. methods and locations of processing, storage, and disposal of radioactive materials at the site;
3. quantities and physical forms (gas, liquid, or solid) of the radionuclides processed, stored, or disposed of;
4. amount and quality of radiological monitoring and survey data available;
5. radionuclides known or suspected to remain at the site;
6. areas and equipment that are, or may be, contaminated, and occupancy of contaminated areas;
7. equipment and materials history used during and after exposure to radioactive material (e.g., D&D, general cleaning, parts replacement); and
8. current condition, ownership, and legal property boundaries of the site.

• Interviews

Determine if any persons currently at the site were associated with the operations and activities on the site during the period when the radiological material was or may have been in use. It is usually helpful to identify and interview former owners, operators, or employees. Personal interviews may provide additional input into the evaluation of requirements for the survey. Documentation of these interviews must be retained. When records are incomplete or confusing and conditions complex, input from cognizant individuals may be essential to a good survey. Interviews should include individuals knowledgeable in records disposition for the facility as well as those familiar with radiological operations.

• Ground-level or aerial survey results

If a ground or an aerial radiological survey has been made, obtain and review the results with particular emphasis on location and intensity of anomalous radiation levels. These locations should be considered in developing the detailed survey plan.

• Site geography and topography

Review the site geography and topography. If means of migration of contamination to surrounding water bodies, vegetation, grazing land, etc., are identified, the survey plan should include provisions for appropriate measurement of suspect areas.

• Facility drawings/photographs

Review the facility drawings and photographs of previous processing and radioactive material or waste handling areas, and locate potentially contaminated equipment and open areas. Note previous process and waste flows to and from the facility. Such information will facilitate planning and result in an effective survey program.

2.2.3 Present Use of Facility

Review the current site usage and layout. Determine if any of the site features have been disturbed since the most recent facility drawings were made. Particular attention must be given to ongoing processes and the number of people involved. In planning the survey, it must be determined whether the survey can be conducted during working hours or if it will be necessary to schedule it for a time when people are not present.

An additional concern is the presence of small items such as equipment and material. See Sect. 4.6 for a discussion of survey techniques for small items.

2.3 SITE VISIT/INSPECTION

The preliminary visit is an on-site information gathering process. The investigator must assemble and review any information that may be relevant to performing the radiological survey, organizing the results into a concise form to assist in the investigation. The purpose in gathering this information is

1. to select those survey procedures most appropriate for the efficient radiological characterization of a site,
2. to prevent redundancy, and
3. to provide information to facilitate or supplement the radiological survey.

Results of the historical reviews and personal interviews should be assembled and put into a concise form to assist in the investigation. The following are typical questions designed to provide the desired information.

1. Who did the original work at the site?
2. What were the starting materials, intermediates, and end products?
3. Where was the process located on the site?
4. Where were raw material and product storage areas?
5. What was the production flow path of radioactive material through the site?
6. What buildings and equipment were used in the process?
7. Is all of the equipment used in the process presently located on the site, and if so, where? If not, where is it?
8. What areas have been previously subjected to decontamination, and what were the results of those activities?
9. Is there a possibility of off-site contamination (e.g., note any site/facility drainage or runoff areas that may have concentrated or collected residuals)?
10. Will site assessment require local, State or Federal documentation such as National Environmental Policy Act (NEPA 1969) documentation or documentation from other Federal regulations and/or acts; e.g. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA 1976), Resource Conservation and Recovery Act (RCRA 1976), etc.? It may also be useful to evaluate the need for such documentation for the remediation activities as well.

An abbreviated radiological survey may be performed during the preliminary site visit to establish the presence of contamination and to provide input for the decision to conduct a more comprehensive radiological survey. This may also be required to verify that there is no need for immediate action.

The probable pathways (routes) by which personnel and/or the public may be exposed to radiation associated with the site should be identified. The pathways may be one or more of the following:

1. direct exposure to radiation;
2. inhalation of radioactive particulates or gases; or
3. ingestion of radioactive materials through water or food, and in some cases, soil.

The identification of the probable pathways will help determine the types of measurements to be made and the samples to be collected.

2.4 SUMMARY OF FINDINGS

A final summary report, which may be an informal listing rather than an official document, should be prepared either as a separate report or as part of the survey plan. The summary of

findings should provide guidance for the conduct of survey operations and should include a synopsis of all of the historical and factual information described in the preceding discussion.

3. SURVEY PLANNING

3.1 SELECTION OF TYPE OF SURVEY

The survey types are differentiated by objectives, content, and amount of data to be obtained. The following provides for five classes of surveys based on objectives and structure, encompassing all efforts required for a complete site evaluation, remediation, and release. The selection of survey type will depend on the assessment of the total information collected as described in Sect. 1 (Fig. 1.1). Survey nomenclature are designed to provide concise descriptions of the survey content and objectives that meet DOE or other requirements.

3.1.1 Scoping

If the data collected in the preliminary investigation and preliminary site visit/inspection are not adequate to either verify that the site has low potential for contamination or there is not sufficient information to plan a survey, a scoping survey is indicated. If it is probable that contamination is present at levels exceeding criteria, a characterization survey should be conducted (see Fig. 1.1 and Sect. 3.1.2).

The primary objective of this type of survey is to provide site-specific information based on actual measurements and sampling to determine

(1) if residual radioactive materials are present on the site, and, if so, do concentrations or levels exceed applicable guidelines; and
(2) if the data are sufficient to estimate possible health risks?

Scoping surveys are conducted after preliminary site visits and involve measurements aimed at providing enough data to determine whether further investigation is warranted. If contamination is present, a more detailed characterization is necessary; if no contamination is present, no further surveys are required for the site. Sufficient data should be collected to identify situations that require immediate radiological attention. For sites where the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA 1976) requirements are applicable, the scoping survey should collect sufficient radiological data to support the Preliminary Assessment/Site Investigation (PA/SI) portion of the process.

National Environmental Policy Act (NEPA 1969) requirements for a cleanup would be handled independently of this manual. For sites where extensive clearing, brush removal, etc., is needed before surveying, an environmental assessment and a brief ecological impact analysis may be warranted. These actions could also be considered as part of the overall remediation environmental analyses.

3.1.2 Characterization

A characterization survey may or may not be preceded by a scoping survey. If the data indicate a potential for radiation levels exceeding guidelines and are sufficient to permit the preparation of a survey plan, a characterization survey is indicated.

This type of survey is an extensive, detailed, radiological characterization including gridding and sampling. It is aimed at providing data for source terms for risk/dose analyses, ALARA* assessments, cost estimates, recommendations for remedial actions, and detailed locations and magnitudes of contaminants. This is the most comprehensive of all the survey types and provides the most data. Situations requiring immediate radiological attention should be indicated by the results. When CERCLA is applicable, data should be sufficient to support the Remedial Investigation/Feasibility Study (RI/FS) portions of the process.

3.1.3 Remedial Action Support

If the site has been well characterized and is contaminated, a decontamination plan should be prepared and a remedial action support survey conducted during implementation of the plan.

This type of survey is performed while site remediation is being conducted. Its purposes are to provide an indication that the contaminants are actually being removed, to monitor the progress of the decontamination, and to verify that personnel are adequately protected.

3.1.4 Final Status

These surveys are performed to provide sufficient data to demonstrate that the contamination has been removed (i.e., that the site meets the criteria for release for appropriate future use or, where appropriate, designated restricted use) and that no unacceptable health risk exists. Final status surveys are detailed (i.e., use existing grid or develop a new system, perform scanning, systematic soil sampling, and subsurface sampling) and essentially provide a new site characterization. However, the details should be commensurate with the need.

3.1.5 Confirmatory/Verification

If the data suggest that the potential for contamination is low, or if the site has been decontaminated and is ready for release, a confirmatory/verification survey is indicated.

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*ALARA is the acronym for "as low as is reasonably achievable" and describes the approach to radiation protection used by DOE to control or manage exposures to, and releases of, radioactive material. Its objective is to attain dose levels as far below the applicable limits of Order DOE 5400.5 as practical considering technical, economic, safety, and social factors.

The objective of the confirmatory / verification survey is to verify that all characterization, remediation, and post-remediation work is adequate to demonstrate that the site is radiologically clean relative to applicable criteria and acceptable for release for appropriate future use or, where suitable, designated restricted use. DOE typically recommends that this work be done by an organization that is independent of the contractor conducting the remediation to validate the accuracy and completeness of the field measurements and attest to the credibility of the cleanup and certification operations. Although field measurements and sampling are usually necessary, much of the work required for this survey type will involve review and evaluation of documentation and data from previous site surveys. A site visit to observe final survey procedures and a review of results, perhaps with some split sample analyses, may be all that is required.

3.2 SURVEY WORK PLAN

After the type of survey needed has been determined, a survey work plan should be developed. General requirements for each survey type, organized in matrix format, are provided in Fig. 1.2. The generic matrix plan is designed to provide sequential guidance in conducting radiological surveys in a manner consistent among DOE contractors. The matrix is intended to serve as generic guidance applicable to the majority of sites. However, it is also recognized that developments during the conduct of the survey may indicate a need to increase survey activities in selected areas of the site while reducing them in others. It is important that the survey be completed in accordance with the plan, but it is also important that the survey team have the flexibility to incorporate new information into the process. Therefore, the survey plan should recognize the need for flexibility and should identify those qualified and experienced individuals authorized and responsible for making field modifications of the plan. If possible, it should outline conditions where such modifications are necessary and when approval by higher management than the survey leader is required. Exceptions to the generic plan / matrix should be recognized as early as possible and resolved with input from all affected parties.

Local and State regulations may require formal approval in the form of environmental permits prior to sampling. This fact should be attended to early in the planning process to avoid later delays. For instance, some states may require a well permit for sampling or drilling holes of a certain size or in particular areas. An additional consideration is the necessity to devise a site-specific health and safety plan (HASP) detailing anticipated hazards and emergency response procedures. Prior to conducting any site investigation where suspected or known quantities of radionuclides and / or hazardous wastes have been employed, an evaluation of worker safety issues according to HAZWOPER requirements (29 CFR 1910.120) is mandatory. This assessment will be based on the available historical information and the levels of suspected contaminants. For all sites, this is an important first step prior to site access and subsequent determination of a site's radiological status.

It is not within the scope of this manual to specify the applicability of each Federal and State environmental law or guidance document to planning, conducting, and evaluating a radiological survey; however, it is important to mention that this assessment process must be in accord with applicable Federal and State laws, and DOE orders and regulations. Furthermore, it is recommended that the level of survey detail and data reporting requirements should be evaluated with respect to the intended uses of the data [e.g., to meet Data Quality Objectives (DQOs) to support remedial actions, etc.]. The reference section includes three detailed sources listing proposed EPA guidance for developing DQOs for site-specific remedial activities (EPA 1987b, EPA 1994a, and EPA 1994 b).

When developing a site-specific work plan, it is neither feasible nor possible to perform measurements or conduct sampling at the theoretically infinite number of locations on a site. Instead, a survey should have as its objective the collection of quality radiological data from representative site locations, such that a sound conclusion regarding the radiological status of the entire site can be developed.

Consideration should be given to surveying equipment and small items (e.g., equipment or personal property) for both indoor and outdoor surveys. Procedures for equipment / small items are described in Sect. 4.6.

• Outdoor

Depending upon site processes and operating history, the areal extent of the radiological survey may include varying portions of the site areas. At a minimum, those areas immediately adjacent to facilities where radioactive materials were handled must be surveyed. Other potentially contaminated open land or paved areas to be considered include

- equipment, product, waste, and raw material storage areas;
- liquid waste collection lagoons;
- areas downwind (based on predominant wind directions on an average annual basis, if possible) of stack release points;
- areas in the vicinity of exhaust vents (e.g., roofs, window ledges, etc.);
- storm sewers, septic systems, or sanitary sewers where building drains exist and connect to such systems;
- surface drainage pathways, including storm sewers and any other locations where runoff materials could concentrate; and
- roadways that may have been used for transport of radioactive or contaminated materials.

Areas investigated should include any credible release mechanism that may have resulted in redistribution or dispersion of contaminants. Equipment and locations not immediately obvious or accessible should be investigated (e.g., heating / air conditioning system components, vaults, excavated areas or crawl spaces beneath buildings, underground storage tanks, etc.).

• Indoor

Preparations for surveys of buildings involve identifying the surfaces of interest, again dependent upon site processes and operating history, and establishing a survey reference system when applicable. Contaminated indoor surfaces, structures, and equipment may include overhead support beams, hot cells, fume hoods, piping, and ducts. Painted surfaces may require extra attention to assure detection of attenuated alpha radiation. Of special concern are joints between walls or between walls and floors, pipe or conduit runs, and liquid lines buried in walls, floors, or the ground. Attention also should be directed toward potentially hidden or concealed surfaces or areas that may have become contaminated. Scale drawings of the survey areas and facility features, if available, would be a useful adjunct to the preparation of drawings for specific use during the conduct of a survey.

Consideration should be given early in the planning process to the constraints produced by current occupancy of potential survey areas.

3.3 CONSENT FOR SURVEY

When facilities, sites, or off-site equipment are not owned by DOE or DOE contractors, the responsible DOE organization will either directly, or through a designated contractor, acquire written and signed consent from the site or equipment owner to access the property to conduct the required surveys. All appropriate local, State, and Federal officials, as well as the site owner and other appropriate individuals, should be notified of the survey schedule.

3.4 IMPLICATIONS OF HAZARDOUS SUBSTANCES AND MIXED WASTES

A thorough discussion of NEPA, CERCLA and the Resource Conservation and Recovery Act (RCRA 1976) exceeds the scope of this manual; however, consideration must be given to the discovery of hazardous substances and/or generation of mixed waste during site reconnaissance. A hazardous substance is any substance that when released to the environment in an uncontrolled or unpermitted fashion becomes subject to the reporting and possibly response provisions of the Clean Water Act (CWA 1972)* and CERCLA. Any radioactive ". . . .source, special nuclear material, or by-product material as defined in the Atomic Energy Act (AEA) of 1954 . . ." is itself a hazardous substance under CERCLA and has its own associated reportable quantities (RQs).**

*Sects. 311(b)(A)(a), 307(a), and 402.

**If a hazardous substance release exceeds permitted levels, and if the amount of the release exceeding the permitted level is equal to or more than the hazardous substance's reportable quantity (RQ), then the release must be reported to the National Response Center. If the hazardous substance is also an extremely hazardous substance as defined in 40 CFR 355, Appendix A, and the release extends beyond the facility boundary, then the State Emergency Response Commission (SERC) and community emergency coordinators for areas likely to be affected must also be notified. (See also 40 CFR 302.6, Notification Requirements).

Section 311(b)(2)(A) of the CWA requires the designation of "hazardous substances" that when discharged into or upon navigable waters of the United States are subject to certain reporting and response requirements. These hazardous substances and their corresponding reportable quantities (RQs) are listed in 40 CFR 117.3.

The scope of CERCLA is broader than that of any other environmental statute. Section 101(4) of CERCLA expands the universe of hazardous substances and has its own reporting and response requirements when a release to any environmental medium exceeds an RQ. CERCLA defines a hazardous substance as

- any substance designated under Sect. 311(b)(2)(A) of the CWA;
- any element, compound, mixture, solution, or substance designated as hazardous pursuant to Sect. 102 of CERCLA;
- any listed or characteristic RCRA hazardous waste;
- any toxic pollutant listed under Sect. 307(a) of the CWA;
- any hazardous air pollutant listed under Sect. 112 of the Clean Air Act (CAA 1990)*; and
- any imminently hazardous chemical substance or mixture subject to Sect. 7 of the Toxic Substances Control Act (TSCA 1976).

A list of CERCLA hazardous substances and corresponding RQs is found in 40 CFR 302.4. All CWA Sect. 311 hazardous substances are also CERCLA hazardous substances, but not vice versa (the 40 CFR 302.4 list is larger than the 40 CFR 117.3 list). RQs under the two lists are supposed to be equivalent.

A mixed waste contains both radioactive and hazardous waste as defined by the AEA and RCRA, respectively. The radionuclide portion of a “mixed” waste is regulated under authority of the AEA; the hazardous waste component is regulated under the authority of RCRA. As a practical matter, the two components of mixed waste often cannot be separated and must be regulated under both authorities.

When suspect hazardous substances are encountered during a radiological survey, regardless if stated substance is anticipated or unexpected, a mechanism for the proper notification to DOE line management** and other regulatory authorities should be

*Sect. 112, PL 88-206, as amended (Nov. 15, 1990).

**Whenever the user is uncertain of the requirements, DOE line management must be consulted to avoid deviating from regulations or from DOE policy. The survey plan must include the manner in which the health physicist and/or supervisory personnel will be made aware of the requirements of Order DOE 5000.3 to properly implement reporting notifications.

specified in the survey plan. Note that other materials of significance (e.g., asbestos) encountered during site surveys should be reported to the DOE line management.

To be regulated under RCRA, a material must first meet the definition of solid waste.* A solid waste is also a "hazardous waste" if (1) it is listed in 40 CFR Part 261, Subpart D, as a hazardous waste; (2) it is hazardous by the characteristic of ignitability, corrosivity, reactivity, or the Toxicity Characteristic Leaching Procedure (TCLP); (3) it is a mixture of a solid waste and a hazardous waste; or (4) it is derived from the treatment, storage, or disposal of a listed hazardous waste. Liquid wastes that fall into one of these categories are also classified as solid hazardous wastes.

RCRA imposes "cradle-to-grave" management requirements on the generation, transport, and treatment/storage/disposal (T/S/D) of solid hazardous waste with the objective of protecting human health and the environment. EPA's regulations implementing RCRA at 40 CFR Parts 260-268, 270-272, 280, and 281 establish (1) detailed reporting mechanisms for continuous accountability in handling hazardous waste; (2) detailed and specific technical standards for treatment, storage, and disposal of hazardous waste; and (3) a permitting system for treatment, storage, and disposal facilities to ensure adherence to technical standards.

3.4.1 Unexpected Discovery or Suspicion of Hazardous Substances

If a factual or suspect hazardous substance problem is encountered in conducting a site radiological survey where hazardous substances are not expected and not considered in survey planning, the finding should be documented and reported to the DOE line management. Consideration must first be given to worker safety issues when a suspect or factual hazardous substance has been encountered during a site radiological survey. It may be necessary to implement a stop-work directive to identify the suspect substance and evaluate safety and health issues for that particular phase of survey work. The survey work plan should be modified to reflect changes in requirements and procedures for employee protection. For example, if odors indicative of a chemical source are detected during soil sampling, DOE line management should be notified. Indications of hazardous material include pooled liquids or solids, sludges, unmarked drums and canisters, evidence of leaking tanks, and soil and surface discoloration. Subsequent determinations in the scope of work should be reevaluated. An unplanned or unexpected hazardous substance problem during a site survey would be likely to impact worker safety and/or the storage, treatment, and disposition of samples suspected of containing hazardous waste.

*"Solid wastes" include garbage, refuse, sludge from waste or water treatment plants or air pollution control facilities, and other discarded material, including solid, liquid, semisolid, or gaseous material from industrial, commercial, mining, agricultural operations, and community activities. Solid wastes do not include solid or dissolved material in domestic sewage; irrigation return flows; industrial discharges permitted under Sect. 402 of the CWA; or source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954 [AEA, Sect. 1004(5)]. In the implementing regulations for RCRA at 40 CFR 261, Subpart C, characteristics of hazardous wastes are identified as ignitable, corrosive, reactive, or toxic. Over 400 hazardous wastes are listed at 40 CFR 261, Subpart D. These wastes are divided into three categories: (1) hazardous wastes from nonspecific sources (40 CFR 261.31); (2) hazardous wastes from specific sources (40 CFR 261.32); and (3) discarded commercial chemical products, off-specification species, container residues, and spill residues (40 CFR 261.33). All RCRA Subtitle C hazardous wastes are also CERCLA hazardous substances.

3.4.2 Anticipated Finding of Hazardous Substances

If there is reason to suspect a high probability for encountering hazardous substances during a radiological survey (e.g., during soil sampling), the survey plan should indicate this, and accordingly, survey preparations should be in place for integrating both radiological and hazardous waste regulatory requirements. The survey plan should address worker safety issues and requirements for the storage, treatment, and ultimate disposition of mixed waste. As previously noted, a mechanism for the proper notification of a suspect or factual hazardous substance finding should be specified in the survey plan.

3.4.3 Generation of Mixed Waste During Radiological Surveys

A plausible mixed waste encounter could occur during the collection and/or storage of radioactively contaminated environmental media. As expected during environmental sampling, physical wastes are generated. However, if during any portion of the site reconnaissance process contaminated soil is excavated, subsequently moved, and "placed" at a clean, uncontaminated area, this excavated soil could be subjected to the RCRA Land Disposal Restriction (LDR) regulations. The EPA considers movement or placement of materials from one unit to another to be "disposal." Disposal of RCRA hazardous waste* is no longer allowed without treatment to meet the LDR standards. If generated wastes have been verified as RCRA hazardous waste, then RCRA requirements are in effect for the proper storage, treatment, and disposal of the waste, even if the action is conducted under the authority of CERCLA. Samples and other produced materials that are classified as mixed waste will necessitate the special handling requirements dictated under both the AEA and RCRA.

In accordance with requirements of the Federal Facilities Compliance Act of 1992, all DOE and DOE contractors shall comply with the requirements of the NEPA as specified in Order DOE 5440.1E (National Environmental Compliance Program). Additionally, Order DOE 5400.4 (CERCLA Requirements) calls for integration of NEPA and CERCLA requirements for DOE remedial actions at CERCLA sites. The EPA has provided two reports entitled CERCLA Compliance with Other Laws Manual, Vols. I and II (EPA 1988b, 1989a), which are intended as guidance documents for CERCLA compliance with environmental and public health statutes in implementing remedial actions.

*A hazardous waste is a solid waste that must be treated, stored, transported, and disposed of in accordance with applicable requirements under Subtitle C of the Resource Conservation and Recovery Act (RCRA). Section 04(5) of RCRA defines "hazardous waste" as "a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical or infectious characteristics may (A) cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed."

3.4.4 Remedial Actions and Mixed Waste

The generation of mixed waste during site remedial activities mandates adherence to applicable regulations involving the storage, treatment, and disposal of such waste. The remedial action survey plan should outline these requirements, and survey preparations should be made to manage mixed waste problems. One operation during remedial action activities where mixed waste issues should be addressed is the release of materials from a remediated site (e.g., soil).

Unrestricted Release. Where a site is being remediated by the DOE, soils may be released from DOE radiological control as specified in Order DOE 5400.5. For example, if soils generated from remedial action operations contain PCBs, specific criteria must be met before off-site shipment of waste to an authorized facility holding permits authorized under TSCA. These include the following:

- the responsible DOE office has reviewed the shipment under the ALARA process, and the treatment will not result in any significant changes to the material that would invalidate the ALARA determination (i.e., it may be invalid if the treatment process will significantly concentrate the radionuclides);

- the DOE office has coordinated with the appropriate State(s) agency and EPA regional office;

- the materials meet the waste acceptance criteria or permit requirements of the treatment facility; and

- the material has been appropriately characterized and the documented results are consistent with the requirements of Order DOE 5400.5 and associated guidance.

Note that such a release must also conform to the requirements of the CERCLA process, applicable NEPA, and as appropriate, Order DOE 5400.5 requirements for State and local coordination.